

**REVISED EXHIBIT B - CLEANUP ACTION PLAN (REVISED MARCH
2005)**

VOLUME 4

GAS WORKS PARK ENVIRONMENTAL CLEANUP

CLEANUP ACTION PLAN (REVISED)

Prepared for

CITY OF SEATTLE

Department of Parks and Recreation
800 Maynard Avenue South, 3rd Floor
Seattle, Washington 98134

PUGET SOUND ENERGY

815 Mercer Street, MER-04
Seattle, Washington 98104

Originally Prepared by

PARAMETRIX, INC.

5805 Lake Washington Boulevard N.E.
Kirkland, Washington, 98033

with contributions from

THERMORETEC, INC.

1011 S.W. Klickitat Way
Seattle, Washington 98134

June 18, 1999

Revised by

CITY OF SEATTLE

DEPARTMENT OF PARKS & RECREATION

March 1, 2005

DECLARATIVE STATEMENT

TABLE OF CONTENTS

	<u>Page</u>
DECLARATIVE STATEMENT	ii
1. INTRODUCTION.....	1-1
2. SUMMARY OF SELECTED CLEANUP ACTIONS	2-1
2.1 UPWELLING TAR SOURCES	2-1
2.2 SOIL	2-1
2.3 GROUNDWATER.....	2-1
2.4 SEDIMENTS	2-2
2.5 INTERIM ACTION	2-2
3. CLEANUP STANDARDS	3-1
3.1 SPECIFICATION OF CLEANUP STANDARDS	3-1
3.2 SELECTION OF CLEANUP ACTIONS	3-2
3.3 REMEDIATION LEVELS (CLEANUP ACTION LEVELS).....	3-3
3.4 CLEANUP LEVELS.....	3-4
3.4.1 Soil	3-4
3.4.2 Groundwater.....	3-5
3.5 POINTS OF COMPLIANCE	3-6
3.5.1 Soil	3-6
3.5.2 Groundwater.....	3-1
4. DESCRIPTION OF THE PROPOSED CLEANUP ACTION	4-2
4.1 CLEANUP ACTION COMPONENTS	4-2
4.1.1 Air Sparging With Soil Vapor Extraction.....	4-2
4.1.2 Soil Cover.....	4-7
4.2 COMPLIANCE MONITORING	4-9
4.2.1 Soil	4-9
4.2.2 Water.....	4-9
4.2.3 Waste Materials.....	4-9
5. SUMMARY OF NON-SELECTED CLEANUP ACTIONS AND JUSTIFICATION FOR THE PROPOSED CLEANUP ACTION	5-1
5.1 EVALUATION CRITERIA	5-1
5.2 COMPARATIVE EVALUATION AND SELECTION OF RECOMMENDED ALTERNATIVE	5-1
6. IMPLEMENTATION SCHEDULE	6-1
7. INSTITUTIONAL CONTROLS AND SITE USE RESTRICTIONS	7-1
8. JUSTIFICATION FOR SELECTING LOWER PREFERENCE CLEANUP TECHNOLOGIES	8-1
9. COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS	9-1

10.	COMPLIANCE WITH MTCA REQUIREMENTS	10-1
10.1	THRESHOLD REQUIREMENTS	10-1
10.1.1	Protect Human Health and the Environment	10-1
10.1.2	Comply with Cleanup Standards.....	10-1
10.1.3	Comply with State and Federal Laws	10-1
10.1.4	Provide Compliance Monitoring.....	10-1
10.2	OTHER REQUIREMENTS	10-1
10.2.1	Use Permanent Solutions.....	10-1
10.2.2	Provide Reasonable Restoration Time Frame	10-3
10.2.3	Consider Public Concerns.....	10-4
11.	MANAGEMENT OF HAZARDOUS SUBSTANCES REMAINING ON THE SITE ..	11-1
12.	REFERENCES	2

APPENDICES

- A STATE ENVIRONMENTAL POLICY ACT (SEPA) ENVIRONMENTAL CHECKLIST
- B DETERMINATION OF NON-SIGNIFICANCE (DNS)
- C MEMORANDUM FROM THERMORETEC TO THE DEPARTMENT OF ECOLOGY DATED APRIL 12, 1999

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
4-1 Plan View of Proposed Air Sparging/SVE System	4-3
4-2 Proposed Air Sparging System Detail	4-4
4-3 Proposed Soil Cover and SVE System Detail	4-6
6-1 Preliminary Implementation Schedule for Gas Works Park Cleanup Action	6-2

LIST OF TABLES

<u>Table</u>	<u>Page</u>
3-1 Cleanup levels for soil, Gas Works Park.	3-5
3-2 Cleanup levels for groundwater, Gas Works Park.	3-7
5-1 Comparison of cleanup action alternatives.....	5-2
9-1 Summary of state and federal laws potentially applicable to cleanup actions at Gas Works Park.	9-2

1. INTRODUCTION

Gas Works Park (the Park) is the former location of a coal and oil gasification plant that operated from 1906 to 1956. The City of Seattle (the City) purchased the Park property from the Washington Natural Gas Company (now Puget Sound Energy) in 1962 and developed it into the Park, which opened in 1976. Studies conducted at the Park in the 1970s and 1980s indicated the presence of soil and groundwater contamination from the former gas plant operation. The Washington State Department of Ecology (Ecology), through execution of an Agreed Order dated August 1, 1997, required the City and Puget Sound Energy (PSE) to complete a Focused Feasibility Study (FFS) of cleanup alternatives and a Cleanup Action Plan (CAP) describing the recommended cleanup alternative. The FFS and supporting data are presented as Volumes 1 through 3 of the Gas Works Environmental Cleanup documents.

This CAP is Volume 4 of the Gas Works Park Environmental Cleanup documents and meets the requirements specified in Chapter 173-340-360(10) through (12) WAC, the Model Toxics Control Act (MTCA). The State Environmental Policy Act (SEPA) Checklist, Appendix A to this Cleanup Action Plan, has been completed per the requirements of Chapter 173-340-350(6)(h) WAC (the MTCA regulations) and of Chapter 197-11 WAC (the SEPA regulations). A determination of non-significance (DNS) for the actions proposed in this Cleanup Action Plan was declared by Ecology and is included as Appendix B.

2. SUMMARY OF SELECTED CLEANUP ACTIONS

2.1 UPWELLING TAR SOURCES

In 1997, the City and Puget Sound Energy (PSE) characterized known and suspected tar seeps at the Park, and conducted an interim action that removed and destroyed (by thermal desorption) as much of this material as practicable. The following year, additional tar surfaced from the general area of the previous excavations and was removed and treated. As part of this Cleanup Action Plan, the City and PSE will continue to remove and treat any residual tar which might seep from these and other areas¹.

2.2 SOIL

Much of the subsurface soil at Gas Works Park is contaminated with chemicals known as Polynuclear Aromatic Hydrocarbons (PAHs). Additionally, the site contains material that could be classified as Extremely Hazardous Waste² (EHW) under the State's Dangerous Waste Regulation (Ch. 173-303 WAC)³. Excavation and treatment of this material to a depth of 15 feet is technically impracticable⁴.

Contact with underlying soils could result in unacceptable risks to Park users. Direct contact will be prevented by application of containment technologies and institutional controls. The proposed cleanup action for the Park includes placing a new vegetated soil cover over unpaved open areas ~~in the north-central and southeastern portions~~ of the Park.. The soil cover will serve as a protective barrier between Park users and chemicals of concern.

2.3 GROUNDWATER

The groundwater at the southeast part of the Park is contaminated with oil, benzene, and other organics. An interim action to remove free product was initiated in October of 1998. The selected remedial action will consist of a system of air sparging and soil vapor extraction (SVE). This action will reduce contaminant concentrations in groundwater from 642 mg/L to 0.43 mg/L. Modeling of the biological attenuation of benzene estimates that, following treatment by air sparging/SVE, surface water criteria at discharge points into Lake Union will be met within 2 to 27 years. The

¹ During the Public Comment period, concern was expressed about possible tar and free product seepage near the Prow area of the Park.

² In this case, material that contains in excess of 1% total polynuclear aromatic hydrocarbon content by weight.

³ Washington Administrative Code

⁴ Due to the complexities associated with coal tar migration in subsurface media at this site, coal tar accumulations would be difficult to locate. Conventional remediation methods, such as excavation, direct pumping, and groundwater treatment, generally are not effective for removing coal tar from the subsurface. It is estimated that less than 1 ton of material that could potentially be classified as EHW exists on site. This material is randomly distributed throughout the site and approximately 385,000 cubic yards of soil (much of it below the water table) would need to be excavated to ensure its complete removal. It is estimated that the cost of excavation and treatment would exceed \$80,000,000. More information is available in the April 12, 1999 memorandum from ThermoRetec to Ecology "Extremely Hazardous Waste" (attached as Appendix C).

variation of restoration time frames depends primarily of the oxygen content of the aquifer. This cannot be accurately predicted before implementation of the air sparging/SVE remedial action and must be measured afterwards.

The groundwater at the western portion of the Park is contaminated with PAHs (including carcinogenic PAHs). Page 6-2 of the EPRI study (EPRI 1998) concluded that natural attenuation is reducing the concentrations of these chemicals to surface water cleanup criteria prior to their discharge into Lake Union. The City and Puget Sound Energy will be required to demonstrate that attenuation is actually occurring at a rate sufficient to meet surface water criteria within a reasonable restoration time frame. The effectiveness of attenuation as a remedial action will be evaluated during the first periodic review⁵. Should attenuation not be progressing as anticipated, other more active remedial actions may be required.

Additionally, due to concerns expressed during the public comment period⁶, limited monitoring of MW-19 and MW-17 for chemicals of concern will be required.

2.4 SEDIMENTS

Sediment remediation (including sediment cleanup goals) is not addressed under this Cleanup Action Plan and will take place under a separate decree or order at a later date. Full analysis of any Gas Works Park upland to sediment pathways (including groundwater and shoreline erosion pathways) will be reserved for the next phase of cleanup analysis and action, under a separate decree or order.

2.5 INTERIM ACTION

The FFS field investigation of benzene-contaminated groundwater in the southeast part of the Park, confirmed the presence of light non-aqueous phase liquid (LNAPL), in the form of light oil containing a high percentage of benzene, in the soil pores immediately above the water table and floating on the water table. Results of the cleanup alternative analysis indicated that air sparging and soil vapor extraction, the technologies evaluated in detail, may not extract contamination efficiently due to the potential for emulsifying and dispersing the LNAPL.

With concurrence from Ecology, the City and PSE proceeded with development of plans for an interim action to remove LNAPL in the southeast area of the Park. The objectives of this interim action were to maximize elimination of LNAPL as the major source of benzene contamination to groundwater in this part of the Park, and to diminish the negative impacts that LNAPL could have on future cleanup actions.

⁵ WAC 173-340-420 Periodic review. (1) If the department selects or approves a cleanup action that results in hazardous substances remaining at a site at concentrations which exceed method A or method B cleanup levels established under WAC 173-340-700 through 173-340-760 or if conditional points of compliance have been established, the department shall review the cleanup action no less frequently than every five years after the initiation of such cleanup action to assure that human health and the environment are being protected.

⁶ The hypothesis was proposed by Ecology's Northwest Regional Office that BTEX compounds in the groundwater could mobilize PAHs in the subsurface.

An "Interim Remedial Action Work Plan" was prepared by ThermoRetec (1998) to describe the rationale and implementation details for the interim action. The oil recovery system consists of a network of vertical wells in the southeastern shoreline area. The oil recovery was initiated in October 1998, at a time of year when Park use is greatly reduced. This timing also allowed oil recovery while the Lake Union and adjacent groundwater levels are lower, which is more favorable for oil recovery.

Mobile pumping equipment (e.g., vacuum truck) was used to recover oil and associated groundwater, and to minimize disruption of the park. From October to December, groundwater was pumped once or twice a week. Recovered oil was recycled by a fuel blending process at a permitted off-site facility. The oil recovery operation is ongoing.

3. CLEANUP STANDARDS

Cleanup of the Gas Works Park Site is being done under the authority of Chapter 70.105D RCW⁷, *Hazardous Waste Cleanup – Model Toxics Control Act*, and its implementing regulation, Chapter 173-340 WAC, *The Model Toxics Control Act Cleanup Regulation* (MTCA). This law and regulation apply to the site in their entirety and govern all remedial actions at the site.

The most relevant sections of the statute and regulation with regard to this CAP are the following:

- RCW 70.105D.030(1)(b), which states in part that, “... the department shall give preference to permanent solutions to the maximum extent practicable and shall provide for or require adequate monitoring to ensure the effectiveness of the remedial action.”;
- RCW 70.105D.030(2), which states, “The department shall immediately implement all provisions of this chapter to the maximum extent practicable ...”;
- WAC 173-340-700 through -760, which specify how cleanup standards are to be set for the various environmental media of concern: groundwater, surface water, soil, sediment, and air; and
- WAC 173-340-360, Selection of cleanup actions. This specifies the requirements for cleanup actions and the criteria that are used to evaluate alternatives.

Taken together, the provisions of the statute and the regulation provide strong preference for permanent solutions, set specific cleanup standards for hazardous substances, and give specific requirements for selecting cleanup actions (“solutions”), including selecting remedies that are permanent to the maximum extent practicable.

3.1 SPECIFICATION OF CLEANUP STANDARDS

Specification of a cleanup standard for an environmental medium of concern (i.e., soil, groundwater, surface water, sediment, or air) requires specification of the following:

- Hazardous substance concentrations that protect human health and the environment. These concentrations are called cleanup levels. Indicator hazardous substances may be chosen from among the hazardous substances present at a site to define cleanup requirements.
- The location on the site where cleanup levels must be attained. This location is known as the point of compliance.
- Additional regulatory requirements that apply to a cleanup action because of the nature of the hazardous substances, type of action, location of the site, or other circumstances at the site. These requirements include legally applicable requirements promulgated under state or

⁷ Revised Code of Washington

federal law and relevant and appropriate requirements that, while not legally applicable, address problems or situations sufficiently similar to those encountered at the site such that their use is well suited to the particular site. These “applicable or relevant and appropriate requirements” are usually referred to by the acronym ARARs.

3.2 SELECTION OF CLEANUP ACTIONS

Cleanup actions are selected according to the requirement that cleanup actions must meet the following: threshold requirements; the requirement to select cleanup actions that are permanent to the maximum extent practicable; consideration of restoration time frame; consideration of public concerns; preferences regarding cleanup technologies; and criteria for evaluating the degree to which alternative cleanup actions meet these requirements, considerations; and preferences. The process is set forth in WAC 173-340-360, Selection of cleanup actions.

The threshold requirements, which any cleanup action must meet to be considered for selection, are that the cleanup must:

- Protect human health and the environment,
- Comply with cleanup standards,
- Comply with applicable state and federal laws, and
- Provide for compliance monitoring.

Cleanup action alternatives which Ecology determines meet the above threshold requirements may then be considered for selection of an overall cleanup action.

Overall cleanup actions typically involve the use of several cleanup technologies or methods at a single site. In selecting an overall cleanup action from alternative choices that meet threshold requirements, the degree to which each alternative meets the following requirements is to be considered:

- Use of permanent solutions to the maximum extent practicable. A permanent solution meets cleanup standards without further action being required at the original site or any other site involved with the cleanup action, other than the approved disposal of any residue from preferred treatment technologies. In general, technologies, which reuse, recycle, destroy, or detoxify hazardous substances result in permanent solutions if residual hazardous substance concentrations are below cleanup levels established under MTCA. Containment of hazardous substances and/or institutional controls alone is not permanent solutions.
- Provision for a reasonable restoration time frame. Factors considered when establishing a reasonable restoration time frame include potential risks posed by the site to human health and the environment; the practicability of achieving a shorter restoration time; current and future use of the site, surrounding areas, and associated resources; availability of alternative water supplies; likely effectiveness and reliability of institutional controls; ability to control and monitor migration of hazardous substances from the site; toxicity of the hazardous

substances at the site; and natural processes which reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

- Consideration of public concerns raised during the public comment on the CAP.

When considering alternatives, preference is to be given to those incorporating cleanup technologies that provide greater long-term effectiveness and more permanent reduction of toxicity, mobility, and volume. Technologies that address these issues are considered in the following order of descending preference: (1) reuse or recycle; (2) destroy or detoxify; (3) separate, reduce the volume of, and/or reuse, recycle, destroy, or detoxify; (4) immobilize; (5) dispose of on-site or off-site at an engineered facility; (6) isolate or contain; and (7) provide institutional controls and monitoring. Institutional controls and monitoring are to be used to supplement engineering controls, and are not to be used as a substitute for cleanup actions that would otherwise be technically possible [WAC 173-340-440(2)].

In considering the degree to which alternative cleanup actions use permanent solutions to the maximum extent practicable, the following criteria are to be considered: (1) Overall protectiveness of human health and the environment; (2) long-term effectiveness; (3) short-term effectiveness; (4) permanent reduction of toxicity, mobility, and volume of the hazardous substances; (5) ability to be implemented; (6) cleanup costs; and (7) degree to which community concerns are addressed.

3.3 REMEDIATION LEVELS (CLEANUP ACTION LEVELS)

One other important concept should be discussed with regard to selection of cleanup standards. This concept is termed “remediation level” (or “cleanup action level”). As discussed above, cleanup actions typically involve a combination of technologies, and often not all contamination is taken off-site. A remediation level is a concentration of a hazardous substance at a location within a medium at which a different cleanup technology will be used. There are often multiple remediation levels; e.g. one for removal and treatment/disposal and one for material that may be contained on-site. Remediation levels may be based upon the concentration of a hazardous substance, upon the location of the hazardous substance, and often both. Remediation levels may only be established after all threshold requirements are met. Cleanup actions, which incorporate remediation level(s), must still be protective of human health and the environment and permanent to the maximum extent practicable.

Typically, a lower-preference, less-permanent remedy (such as containment) might be used as the cleanup action to address contaminant concentrations between a remediation level that equals the cleanup the level and a higher remediation level. Where contaminant concentrations exceed this higher level, a more permanent cleanup action (such as removal and off-site disposal) would be applied.

When a remediation level is set for a site it means that cleanup levels will be attained for only a portion of the site and that contamination will be left on-site. Institutional controls are required for sites where contamination remains on-site above cleanup levels.

Cleanup levels and their point of compliance must set for all sites to develop the cleanup standard; remediation levels and associated locations where the remediation levels must be met may or may not be used at a particular site.

In the draft Focused Feasibility Study for Gas Works Park (Parametrix 1998), the City and PSE proposed remediation levels of 10 times the surface water cleanup criteria at inland locations. These remediation levels assumed a dilution and attenuation factor (DAF) of 10 from the point of measurement to the surface water body (Lake Union). During the public comment period, considerable concern was expressed over the validity of the assumptions used in deriving the DAF of 10. Ecology has determined that there is not sufficient evidence available to support the conclusion that an assumed DAF of 10 is protective of human health and the environment. As a result, after installation and operation of the air sparging/SVE treatment system, monitoring will be done to measure the actual DAF at the site and confirm that the remedy is protective.

3.4 CLEANUP LEVELS

3.4.1 Soil

Soil cleanup levels at the Park (MTCA Method B) are based upon a future residential exposure scenario. The current land use at the Park is recreational. Table 3-1 lists the chemicals of concern and their cleanup levels.

Arsenic levels at the site exceed the 90% percentile for the Puget Sound regional background level of 7.3 mg/kg but fall within the range of concentrations observed in the study by Ecology (1994). Considering the present and likely future use of the Park as a recreational area⁸, the MTCA Method A value of 20 mg/kg for arsenic is protective of human health and is acceptable for use as a cleanup level at this site.

Table 3-1 indicates that 1997 soil sample results all exceed the Method B cleanup levels, and are therefore all retained as chemicals of concern. This does not, however, indicate that Park users or workers have been or are currently exposed to unacceptable levels of risk. The risk assessment performed by the University of Washington (Ongerth 1985) concluded that health risks estimated from exposures to PAHs in soils over most of the Park (typical concentrations on the order of 20 milligrams per kilogram) are comparable to or less than exposures received during daily living.

The risk assessment recommended that localized spots of higher PAH in soils be removed or covered with clean material, and that signs be posted to discourage people (mainly children) from placing soil in their mouths. The City immediately implemented these recommendations in 1985. Application of the Method B cleanup levels for soils, which are much lower than the concentrations

⁸ Chemical concentrations protective of human health in a recreational exposure scenario are generally higher than those in a residential exposure scenario due to decreased contact time.

Table 3-1. Cleanup levels for soil, Gas Works Park.

Chemical of Interest	Maximum 1997 Detected Concentration (mg/kg)	MTCA Method B Soil Cleanup Level (mg/kg)	Retained as Chemical of Concern?
<i>Inorganic Chemicals</i>			
Arsenic	10.9	20(1)	Yes
<i>Carcinogenic PAHs</i>			
Benzo(a)anthracene	23.3	0.137	Yes
Benzo(b)fluoranthene	35.4	0.137	Yes
Benzo(k)fluoranthene	12.0	0.137	Yes
Benzo(a)pyrene	36.0	0.137	Yes
Chrysene	27.7	0.137	Yes
Dibenzo(a,h)anthracene	5.57	0.137	Yes
Indeno(1,2,3-cd)pyrene	44.4	0.137	Yes
<i>Other PAHs</i>			
Naphthalene	11.5	3,200	Yes
Pyrene	102	2,400	Yes
Fluoranthene	62.5	3,200	Yes

NOTES:

mg/kg = milligrams per kilogram

PAH = Polynuclear aromatic hydrocarbon

(1) MTCA Method A cleanup level; see discussion in Section 3.4.1

addressed in the risk assessment, is a conservative approach that provides an added level of protection to Park users and workers.

3.4.2 Groundwater

Groundwater cleanup levels at the Park are based on the protection of surface water and will be the MTCA Method B Surface Water Cleanup Levels. In arriving at this decision, Ecology considered that:

- The shallow groundwaters underneath the Park are not usable as a drinking water source⁹
- Lake Union is not usable as a drinking water source¹⁰
- There are known and projected points of entry of the groundwater into the surface water.

⁹ WAC 173-340-720(1)(c)

¹⁰ WAC 173-340-720(1)(c)(ii) requires that the surface water body is not classified as a suitable domestic water supply source under chapter 173-201 WAC. Ecology's Northwest Regional Office has determined that Lake Union is not a suitable water supply source at the adjacent Metro Facilities North site.

- After the completion of cleanup actions, groundwater flow into surface waters will not result in exceedances of surface water cleanup levels at the point of entry or at any downstream location where it is reasonable to believe that hazardous substances may accumulate.
- Institutional controls will prevent the use of contaminated groundwater at any point between the source of hazardous substances and the point(s) of entry of the groundwater into the surface water
- It is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water at concentrations which exceed groundwater quality criteria published in chapter 173-200 WAC.

Table 3-2 lists the chemicals of concern for groundwater and their cleanup levels.

3.5 POINTS OF COMPLIANCE

A point of compliance is the point or points where cleanup levels established in accordance with WAC 173-340-720 through 173-340-760 must be attained.

When hazardous substances remain on-site as part of the cleanup action, the Department may approve a conditional point of compliance which shall be as close as practicable to the source of hazardous substances, not to exceed the property boundary. Where a conditional point of compliance is proposed, the person responsible for undertaking the cleanup action shall demonstrate that all practicable methods of treatment are to be utilized in the site cleanup.

3.5.1 Soil

The point of compliance is the point or points where the soil cleanup levels must be attained. For soil cleanup levels based on human exposure via direct contact, the point of compliance is established in soils throughout the site from the ground surface to 15 feet below the ground surface. Ecology recognizes that cleanup actions involving containment of hazardous substances will typically not meet the soil cleanup levels throughout the site to a depth of 15 feet. In these cases, the cleanup action may be determined to comply with cleanup standards, with the following provisions: a compliance monitoring program ensures the long-term integrity of the containment system; the cleanup action does not rely primarily on on-site disposal, isolation, or containment if it is practicable to reuse, destroy, or detoxify the hazardous substances; and long-term monitoring and institutional controls are implemented until residual hazardous substance concentrations no longer exceed site cleanup levels. [See (WAC 173-340-740(6)(c) and (d)]

MTCA requires that, for land to be returned to unrestricted use, soil cleanup levels be based on human exposure via direct contact with a point of compliance established in the soils throughout the site from the ground surface to 15 feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities [WAC 173-340-740(6)(c)]. However, Ecology recognizes that cleanup actions may be selected which involve containment of hazardous

Table 3-2. Cleanup levels for groundwater, Gas Works Park.

Chemical of Interest	Aqueous Solubility(1) (µg/L)	Maximum Leaching Test Concentrations (4) (µg/L)	Maximum 1997-1998 Detected Concentrations in All Wells (µg/L)	Maximum 1997-1998 Concentrations in Shoreline Wells(6) Conc. (µg/L)	Well No.	MTCA Method B Surface Water Cleanup Level(7) (µg/L)	Retained as Chemical of Concern?
<i>Carcinogenic PAHs</i>							
Benzo(a)anthracene	11	0.6	55	1.6	MLS-7	0.0296	Yes
Benzo(b)fluoranthene	1.5	< 0.6(5)	46.9	< 1.0	--	0.0296	Yes
Benzo(k)fluoranthene	0.81	< 0.6(5)	32.3	< 1.0	--	0.0296	Yes
Benzo(a)pyrene	6.3	0.1	70.1	1.4	MLS-7	0.0296	Yes
Chrysene	1.8(2)	0.4	57.2	0.2	MLS-7	0.0296	Yes
Dibenz(a,h)anthracene	0.5(2)	< 0.6(5)	1.4	< 1.0	--	0.0296	Yes
Indeno(1,2,3-cd)pyrene	0.53(3)	< 0.6(5)	75.2	< 1.0	--	0.0296	Yes
<i>Other PAHs</i>							
Fluoranthene	243	21	198	6.4	MLS-6	90.2	No
Fluorene	1,830	118	172	87	MLS-7	3,460	No
Naphthalene	32,200	19,800	16,000	16,000	MLS-7	9,880	Yes
Pyrene	129	23	246	9.7	MLS-6	2,590	No
<i>Volatile Organic Chemicals</i>							
Benzene	1,786,000	--	642,000	256,000	MW-12	43	Yes
Ethylbenzene	156,000	--	20,800	2,500	MW-12	6,910	Yes
Toluene	542,000	--	222,000	35,900	MW-12	48,500	Yes

NOTES: µg/L = micrograms per liter N/A = Not Available

PAH = Polynuclear Aromatic Hydrocarbon

U = undetected at the given detection limit

(1) MacKay et al. 1992, unless otherwise noted

(2) Montgomery and Welkom 1990

(3) U.S. Army Corps of Engineers 1997

(4) EPRI 1998; from solubility leaching tests, unless otherwise noted

(5) Predicted based on comparison to benzo(a)anthracene, which has a higher aqueous solubility

(6) Shoreline wells include: MLS-6, DW-6, MLS-7, MW-16, MW-21, MW-22, MW-23, MW-24, and MW-25; MW-13 was not considered because it is screened in a lampblack deposit. PAH data are from low-flow purge sampling event conducted in April 1998 (EPRI 1998).

(7) See Section 3.4.2 for application of MTCA B surface water cleanup levels to groundwater

Θ = Exceeds aqueous solubility